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A Yup'ik Research Framework: Center, A Place to Begin

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Globally many Indigenous communities including those in Alaska are calling for culturally based education (CBE). Historically many Indigenous students are unsuccessful on standardized assessments in typical Eurocentric school settings. In order to develop CBE, researchers need to understand ways in which cultural groups comprehend, articulate and use a Eurocentric academic concept. The Yup'ik ethnomathematic research framework, Center Point, described in this paper outlines a holistic approach leading to an understanding of how Yup'ik Elders in the Bristol Bay region of Alaska use mathematical concepts embedded within traditional activities. This approach recognizes the importance of Elders' particular way of thinking and acting that leads to advancing mathematical processes embedded in traditional item construction, such as snowshoes. The proposed new framework is unique because it includes using participant observation methodology and recognizes the Yup'ik knowledge system interconnected elements of spirit, nature, values, and worldview, all of which influence actions.

Keywords:

Ethnomathematics, Center Point, Yup'ik, Indigenous cosmology, epistemology, axiology, pedagogy, culturally-based education (CBE), Indigenous knowledge system (IKS)

Introduction

The 2014 Alaska Native Studies Conference, held on Tlingit traditional grounds in Alaska. Speakers reverberated a call for an "Indigenous framework" in education, in research, and in professional practice. Indigenous scholars Dr. Jo-Ann Archibald and Dr. Malia Villegas, along with Elders, poignantly identified the need to break from traditional dominant research paradigms and to frame Indigenous issues in an Indigenous model and context. An emergent theme was that Indigenous education and research needs to be reflective of the ancestral system of the people being served (researched) in order to honor their culture.

This paper explores the interrelationship of ethnography, mathematics, Indigenous cosmology, epistemology, axiology, and pedagogy that shape the framework for research based on "Center Point," *a place to begin*, a concept that has become central in the Elders' teachings and essential to accuracy in Yup'ik mathematical processes as identified by the Math in a Cultural Context (MCC) team (Lipka, Andrew–Ihrke, & Yanez, 2009). From an ethnomathematics perspective the combination of cosmology, epistemology, axiology, pedagogy, and lifeways is known as an Indigenous knowledge system (IKS).

The Alaska MCC project has existed for nearly 30 years. Yup'ik Elders and educators have partnered with Dr. Jerry Lipka to document some of the Yup'ik everyday activities handed down through generations (Lipka, Mohatt, & Ciulistet, 1998). What is unique and obvious is that the Elders' everyday cultural activities contain accurate and sophisticated mathematical processes, and yet they do not utilize the Western system of mathematical practices. How do the teachings of Yup'ik ancestors lead to the precise construction of items such as a sea-worthy *qayaq* (kayak) vessel, or a *qaspeq* (kuspuk) from a body measure? How can teachings from Elders help Indigenous and non-Indigenous students succeed in Western math classrooms? What are the math processes contained within the Elders' teachings and within cultural item construction? These questions and more are actively being asked within the context of MCC. This type of research is known as ethnomathematics.

The framework described in this manuscript is derived from my role as a doctoral student researcher under Dr. Lipka. My role within the MCC project placed me in the positions of an educator learning to use pervious developed MCC modules and measuring methods, a participant of teacher workshops that assisted the MCC team in developing new modules, and as a participant researcher collecting data by taking photographs, videos, and journal observations. My MCC experience culminated with leading a team in fieldwork in the remote Yup'ik village of Manokotak. We documented Elders' traditional activities of river navigation, doll construction, and traditional teaching and learning between an Elder and a slightly younger Elder within the context of constructing traditional grass items and a qaspeq.

Noted Yup'ik scholar Dr. Oscar Kawagley, in defining Yup'ik IKS, clearly identified the importance of cosmology within the process of teaching in Yup'ik culture (Kawagley, 1995). He described Yup'ik ways of knowing and doing that are intrinsically tied to *Ellam Yua*, the Creator. Dora Andrew-Ihrke and Evelyn Yanez, of Yup'ik ancestry, and Yup'ik researchers and educators revealed nuances of cosmology in Yup'ik lifeways as they demonstrated everyday Yup'ik cultural activities, shared oral history, and provide

direct instruction with guided practice to educators learning to use culturally-based mathematics curriculum (personal observations, 2011, 2012, 2013, 2014).

Axiology, epistemology, and cosmology are familiar terms in ethnographic and scientific research. However, with the rise of the study of IKS over the last 30 years and the development of Indigenous cultural-based schools, these terms are incorporated in publications with an Indigenous meaning for describing a given cultural group's thought process or belief systems. This paper proposes new definitions of these terms as applied to an Indigenous context in comparison with the conventional meanings (Table 1). My proposed framework for research begins by examining critical interrelated concepts--ethnomathematics, Indigenous axiology, Indigenous epistemology and Indigenous cosmology--which will allow me to describe what I learn from the Elders.

	Indigenous K. Parsons 2014	**Classical** Merriam-Webster
Axiology	The values, ethics or morals that guide the search for knowledge and influences actions of a cultural group.	The study of nature, types, and criteria of values and of value judgments, especially ethics.
Epistemology	The way a cultural group thinks and knows; how they engage and use knowledge for a given purpose; includes axiology coupled with how a group thinks about their reality and knows what they know, often learned through oral history and experience.	The study or a theory of the nature and grounds of knowledge, especially with reference to its limits and validity.
Cosmology	A cultural group's view of the origins of the universe inherited from ancestors including axiology and epistemology with a core belief in the interconnectedness of all things and that all living things possess "spirit."	A branch of metaphysics that deals with the nature of the universe.

Table 1. Definition Comparison of Axiology, Epistemology, Cosmology in a Cultural Context

Ethnomathematics Explored & Defined by Bill Barton

What is ethnomathematics? It is a relatively young field of ethnographic research. Bill Barton (1996) sought to develop a common definition of ethnomathematics within the context of educational studies. In doing so, he noted that researchers come to the field of ethnomathematics with different research motives and applications of their research findings. Barton identified four main intentions of ethnomathematic research: 1) *philosophy of mathematics* that debates ways in which mathematical knowledge is culturally based; 2) *cultural mathematics* that

identifies mathematical thought and activity in various cultures; 3) *mathematics evolution* which describes cultural history of mathematics; and 4) *politics of mathematics* as a cultural issue which identifies how mathematics has affected aspects of society. In addition to researchers' various intentions outlined above, Barton identified a variety of descriptions of ethnomathematics as compared to mathematics alone.

The table below (table 2), derived from Barton's (1996) work, compares ethnomathematics and mathematics in the view of ethnomathematicians D'Ambrosio, Gerdes, Ascher, and Lipka. Given that this work is situated within the MCC project, this table adds MCC's principal investigator Jerry Lipka's views to Barton's comparison.

Mathematics	**Ethnomathematics**
D'Ambrosio • Aprioristic: knowledge independent of experience • Closed body of knowledge and changes through the activity of mathematicians • Taught in school, academic • Rational and validated by a hierarchy of authority	*D'Ambrosio* • Relative and evolutionary: knowledge dependent on experience • Continuous interaction with all members of society • Taught informally, practical • Value-bonded and validated by individual's world views • Formation of all knowledge
Gerdes • Western worldview promulgated	*Gerdes* • Living and changing body of knowledge • Active reclaiming of a mathematical point of view as part of Indigenous culture • Mathematics in relation to society
Ascher • Closely defined category of knowledge particular to Western culture	*Ascher* • Intersection of mathematics and culture • Mathematical thinking in context
Lipka • Logical set of propositions that represent an ideal world. i.e. in geometry a line • Math as a science and theory	*Lipka* • integration of mathematical concepts and practices from the target culture to formal mathematics • mathematical threads woven into authentic cultural knowledge and practices • everyday "math" is practical

Table 2. Comparison adapted from Bill Barton's 1996 Educational Studies in Mathematics with additions by K. Parsons

D'Ambrosio, Gerdes, Ascher, and Lipka all defined mathematics and ethnomathematics as being culturally-influenced. Current mathematical instruction in the majority of schools is clearly a Western cultural academic construct taught from a dominant society worldview. It was organized by the Greeks in antiquity and expanded to other countries in

the Middle Ages before taking its current academic form in the fourteenth and sixteenth centuries. As the Grecian mathematics movement (teachings) took a strong hold around the world, Indigenous traditional knowledge systems, which include mathematics, were ignored, rejected, denied, and even suppressed by the dominant society until the twentieth century (D'Ambrosio, 2004).

Currently, mathematics education teaches theoretical decontextualized construct as described by D'Ambrosio, Gerdes, and Ascher. Mathematics is typically taught as linear, progressive thinking that is built from incremental, interwoven, categorical, decontextualized concepts promulgating Western worldviews. Traditionally, mathematics education defines predetermined principles such as algebra, geometry, and calculus, and teaches through theoretical decontextualized constructs.

Ethnomathematics, on the other hand, is indirectly taught through demonstration of practical applications in a given cultural context, usually within an activity containing principles such as algebra or geometry. It is a contextualized living and changing body of knowledge, value-bonded and validated by individuals' worldviews, woven into authentic cultural knowledge and practices with values and a particular way of thinking in the individual's culture. Ethnomathematics also yields insights into additional methods of mathematical instruction---such as the guided practice---that are contextualized, personally applicable, and allow alternative ways of thinking to be explored and validated.

In my education and teaching experiences, students, and parents have openly expressed anxiety about learning school math, confusion about concept application, and a fear of "getting it wrong." Many parents and grandparents have openly stated that they do not understand their children's math homework and cannot help them because they cannot relate to the curricula's application or way of thinking (Personal observations, 2003-2014). When grandparents, parents, and their children all express anxiety and a lack of understanding of math concepts as being taught in schools, then the Western schooling methods have failed three generations. However, experience shows that when mathematics are taught through a joint activity approach with a cultural context, such as drumming, cooking, or fish rack construction, students generally enjoy learning and can explain and discuss the math concepts to a nonparticipant such as their parents.

Cultural activity as a venue for ethnomathematic research

When Elders were asked what term they would use for mathematics, they frequently offered *cuqete-,* or measuring (Kisker et al., 2012). The Yup'ik ancestors measured for practical applications, they did not purposefully teach mathematical concepts or processes for the sake of teaching an isolated process called math. Yup'ik item construction indirectly teaches mathematical concepts and processes through activity. For example, Elders recently explained that when constructing a snowshoe, wood is selected for specific properties, such as hardwood that is fairly straight and of a particular diameter and length (Personal observation, March 22, 2014). The dimensions of the wood are proportional based on the intended snowshoer's body measures. After selecting and peeling the wood, peelings are saved and later used for other construction purposes, as it would be wasteful to discard the bark and not utilize it.

A natural dark small circle that is inside the heart of the wood identifies the Center Point.

The crafter uses the wood's center point to split it in half lengthways, following the natural line of symmetry inherent in the wood. Snowshoes are designed and constructed to the user's body, with proportional measures that allow optimal balance and range of motion. If a person uses snowshoes that are too small or big for them in width or length, they will not be balanced and it will be difficult for them to keep a normal gait. An Elder described how the person's gait would be off and how the snowshoe would behave in relation to the snow, causing the person to prematurely tire. Yup'ik snowshoes are constructed with mathematical precision based on body measures, using principles that can be named in mathematics such as body proportional measuring, estimation, counting, symmetry, splitting, scaling, patterns, visualization, spatial reasoning, angles, length, and area (Personal observation, March 22, 2014).

Yup'ik mathematics is generative, value-based, and embedded in everyday life-ways, as it is within many Indigenous cultures. Ethnomathematics is another Western term coined by researchers in order to describe a culture's practice that includes mathematics, as in the example above.

In 2004 Ubiratan D'Ambrosio, a founding father of ethnomathematics research, presented this description of IKS in the context of ethnomathematics research which supports the Yup'ik snowshoe example:

> The systems of Indigenous knowledge included, particularly, ways of dealing with space and time and different ways of observing, classifying, ordering, comparing, measuring, quantifying, inferring, inventing, plus coherent systems of explanations of facts and phenomena, based on sophisticated founding myths. These are the basic supporting elements of every cultural system and include mathematical ideas present in all these systems. (p. vii)

The proposed IKS research adopts Barton's definition of ethnomathematics: "Ethnomathematics is a research program of the way in which cultural groups understand, articulate and use the concepts and practices which we describe as mathematical, whether or not the cultural group has a concept of mathematics" (Barton, 1996, p. 214). Ethnomathematics is treated here as a component of an IKS containing features described above by D'Ambrosio and Kawagley.

Cosmology within IKS Ethnomathematics Research

Barnhardt and Kawagley described an IKS as the unique way an indigenous population constructs, organizes, uses, and communicates knowledge that has been practiced for centuries. They added that it may contain valid and verifiable classification systems that Western societies would label as mathematics, navigation, physics, chemistry, earth science, astronomy, botany, pharmacology, genealogy, psychology, etc., generated independently from Western ideology with an Indigenous worldview (Barnhardt & Kawagley, 2005). In describing Indigenous research methods of an IKS, Wilson (2008) stated, "The sets of beliefs that make up research paradigms are the interrelated concepts of ontology, epistemology, methodology and axiology" (p. 33).

Bielawski (1990) describes Indigenous knowledge as context-embedded with a correct, spiritually based relationships within the environment (p. 226). She made the point that researchers need to be cognizant of epistemology contained within the culture

being studied in order to conduct valid research in a culturally-respectful method. Likewise, D'Ambrosio (2004) described research of cultural mathematical ideas as comprising a group's cultural history, and in turn, their axiology, epistemology and cosmology.

Beginning with D'Ambrosio in the 1960's, through today, there has been a steady progression of IKS research. Barnhardt, Kawagley, Wilson, Bielawski, Smith and others have identified a need for a holistic research approach that considers worldview, axiology, epistemology, and cosmology in order to fully comprehend the perspective of an Indigenous population, as knowledge and teaching and learning are a social constructs.

Research into an IKS must recognize the nested relationship of a group's Indigenous axiology, Indigenous epistemology, and Indigenous cosmology as shown in Figure 1. They are intrinsically linked and uniquely culture-based.

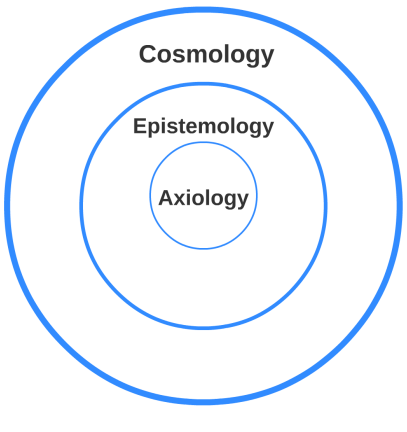

Figure 1. Nested relationships of Indigenous Axiology, Epistemology, and Cosmology

The following example illustrates this nested relationship. Recently, after demonstrating construction of a traditional snowshoe, a Yup'ik Elder engaged me in a conversation about the Yup'ik drum and uses of the drum. He wanted to know my belief and practice of the drum. After explaining that I do own Yup'ik-style drums, and that I play the drum as part of teaching math and for calming upset children, he acknowledged that the drum is very important for dealing with emotions. He continued to explain one ancestral belief in which all the food of all the animals was inside the drum. In January, he advised, it is important to drum and sing pleasing to the spirits. The drumming and signing become requests to Ellam Yua for a plentiful harvest in the future seasons.

This brief conversation about the Yup'ik drum encompasses axiology, epistemology, and cosmology, both nested and interwoven. Furthermore, I believe that conversation is a component of Yup'ik pedagogy. That is, teaching by way of identifying the student's understanding, experience and practice, which is followed by an oral history lesson, in order to further develop thinking patterns.

There was no additional conversation about the snowshoe or drum. However, I thought about the connections between snowshoe construction and the drum lesson. Why did he convey this ancestral belief, which stimulated reflections on the many subtle lessons within the snowshoe construction? Is this a common practice of the Elders, spontaneous oral history lessons that are not followed by conversation or any other communication?

The oral history lesson is essentially a cliffhanger, leaving the student to think through possibilities while making individual and societal connections. This teaches a way of thinking while teaching Yup'ik axiology, epistemology, and cosmology. Thus, we must consider how axiology, epistemology, and cosmology inform mathematical and teaching and learning practices from the perspective of the Elders.

Indigenous Research Framework Design

The framework presented in Figure 2 represents a new ethnomathematic research concept that follows Barton's intention of cultural mathematics. The framework elements guiding this research are: Elders, language, cosmology and worldview, nature/environment, values, pedagogy, cognition, and the MCC project methods. Math concepts identified by MCC surround the Center Point, the place to begin.

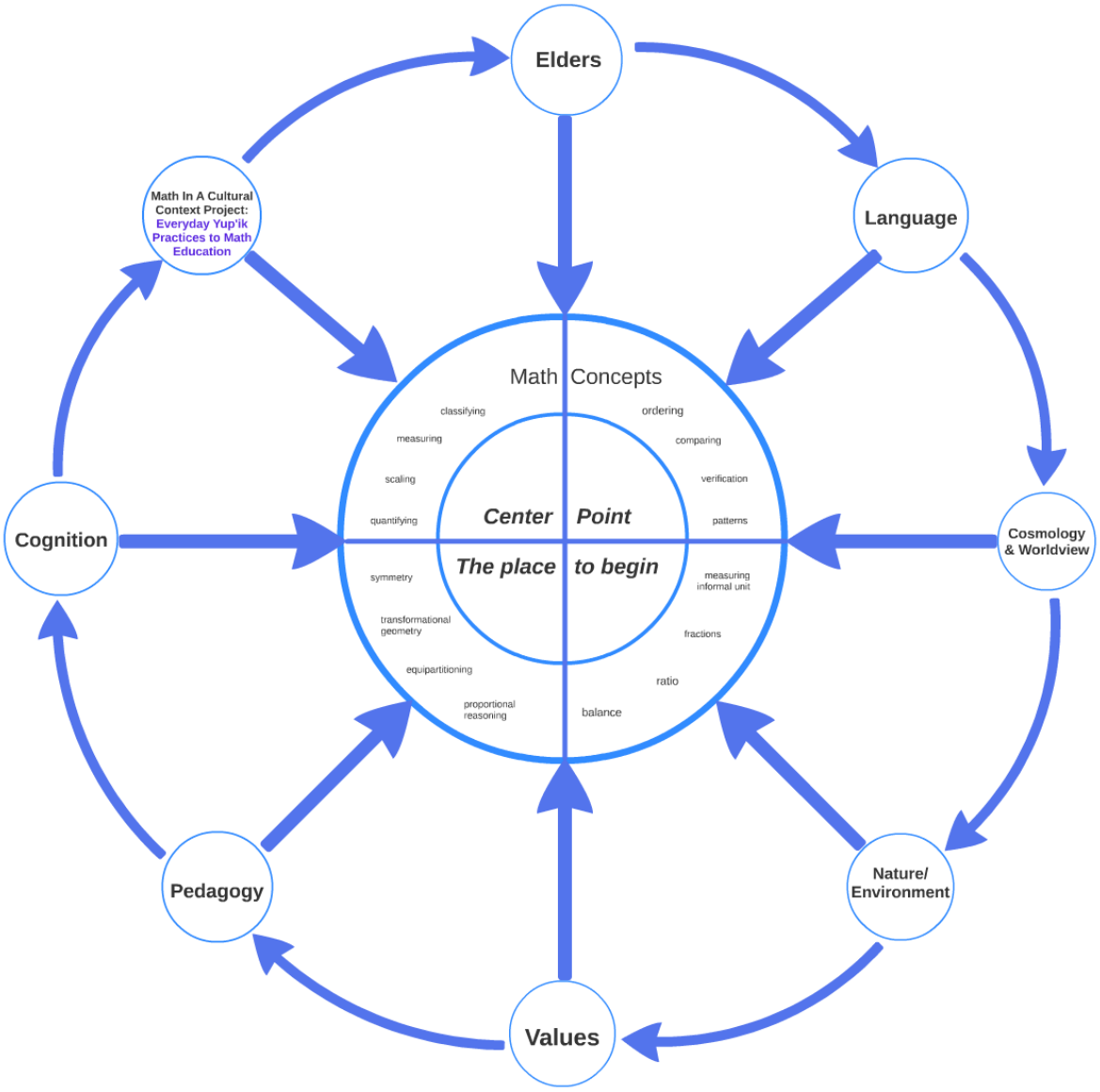

Figure 2. Ethnomathematic Research Framework in a Yup'ik Context

This Indigenous framework (Figure 2) is modeled with what Anne Fienup-Riordan described as the Yup'ik motif of successive levels of encompassment (a circle within a circle) (Fienup-Riordan, 1990).

Yup'ik cultural artifacts frequently display circles within circles. Fienup-Riordan

described the center, or innermost circle as the place where the spirits of the dead, both animal and human, reside in an underworld. The circle around the center marks the human world, and the outer-most circle represents the canopy of the heavens. Yup'ik ancestors described the ability to move between the worlds at various times for various reasons. These realms, human, nature, and spiritual are all interconnected and navigable given the right conditions (Kawagley, 1995).

The circle model presented here begins with the inner-most circle, illustrated as the intersection of two perpendicular lines forming a + for Center Point. The Center Point concept has emerged as a central mathematical Yup'ik concept that Elders describe as part of their way of thinking; it is visualized in the mind and then moved into practice. Yup'ik everyday activities are full of math concepts that are identifiable and describable in Western math education, and are located in the middle circle of the framework.

The outermost circle in the model is formed by linked small circles depicting the interconnectedness of ancestral knowledge as elements of this canopy that make up this Indigenous research framework.

The eight interconnected elements point inward, illustrating that the elements are identifying mathematical concepts embedded in culture.

Elders

Yup'ik Elders are placed in the North position, as seen in Figure 2. They are the most important element of the framework. Elders in this context, does not reference a chronological age, but rather an honored status bestowed by a given community. Elders are knowledge keepers of accumulated historic bodies of Indigenous knowledge, deserving the highest respect. They are considered to be wise, leaders, teachers, and co-parents who contribute to the improvement and also to the well-being of future generations.

All of the other components of the framework are generated from what the Elders freely share about the embedded math in their life-ways, language, ways of knowing, and the worldviews that underlie the cultural traditions and practices. Each Elder brings unique cultural experience from different Yup'ik villages in the Bristol Bay region. When the Elders are brought together they share their knowledge. The Elders verify each other's cultural practices and add depth to concepts with their respective perspectives or village variations.

When construction of a cultural object is the focal point, such as in the previous snowshoe example, a powerful transition takes place. As Elders collectively explain societal history related to the processes of snowshoe construction and uses, the activity pulls them into a collective endeavor to be embraced. The common goal of the activity is to document traditional construction of the snowshoe, as well as documentation of the Elders' perspectives and language that leads to specific mathematical processes.

Language

Yup'ik language is rich with multiple meanings contained in a single word. As a result, Dr. Gary Holton with the Alaska Native Language Center is a MCC project partner assisting in documenting and unpacking the rich knowledge within the language that the Elders use. Essential lessons about math concepts such as symmetry can be understood through language study.

For example, the math concept of symmetry does not exist in isolation within Yup'ik language. The concept of symmetry is a post-base (suffix), which creates embedded meaning within grammar as *verified/good/in balance* and links directly to cosmology. In the case of symmetry, the Elders often speak similarly of item construction as being "in balance" or "good" or "verifiable," all using the post-base in language coupled with demonstration of a symmetrical item. The Elders' descriptive language can reveal patterns of thinking leading to identification of embedded mathematical concepts.

Cosmology and Worldview

The Elders' teachings and language contain embedded cosmology and worldviews, and this framework element is located in the East position. Worldview provides insights into the nested framework of Yup'ik cosmology. Thus, cosmology and worldview are integrated when expressed by Elders. The distinction here is that worldview is a Yup'ik Elder's subjective perspective on the nature of things, reality, mind, actions, and history, in other words, their cognitive and affective perspectives of Yup'ik within the world (Turner, 2008).

Yup'ik Elders reveal their view of the origins of the universe as inherited from ancestors, which contains a core belief in *Ellam Yua*, a central creator or spirit of the universe. Ellam Yua influences methods of construction, spiritual interventions, an existence of the interconnectedness of all things, and that all things of nature possess "spirit," expressed as *anerneq, elillraq, tari, tarnaq*, or *tarneq*, and a practice to live *niuk* (harmoniously) and in *napeckegte* (good balance) with all things. The Elders' teachings and language give rise to an understanding of the way Yup'ik think and know, how they engage and use knowledge to accomplish a given task that is often learned through oral history and experience.

Nature/Environment

Language and cosmology describe an interconnected relationship of the Yup'ik with nature and the environment. The Yup'ik lived successfully with tools and resources provided in nature for thousands of years prior to Western contact. The Elders describe a relationship of balance between Ellam Yua, the Yup'ik, and nature—three important components that maintain a symbiotic existence. Kawagley (2005) identified specifics such as living in harmony with nature; respecting nature's elements of earth, air, fire, water, and spirit; and awareness of spirit within all plants and animals. He described the integration of nature and environment or things originating from nature and environment, in all that is Yup'ik. Nature and environment are components of Yup'ik cosmology and are used to teach values.

Values

Values are placed in the South position of Figure 2. This could also be termed Yup'ik axiology: the values, ethics or morals that guide the search for knowledge and influence their actions to live a good life are embedded in Elder teachings and life-ways. The Elders' teachings and language contain cosmology and worldviews which have values nested within. Axiology is commonly taught indirectly through story, song, dance, or through a passing expression when demonstrating. They are not always spelled out concisely; the listener must pay attention and infer meaning.

A few values identified by Kawagley and Lipka are: pleasing to Ellam Yua; humility; do not waste; pleasing to the eye; introspection; flexibility in thinking;

accuracy, humor; oral history; be respectful; sharing; hard work; knowledge of language; cooperation; and love for children. As noted earlier, those values unfold from the language of the Elders.

Pedagogy

The methods and systems of instruction are known as pedagogy. The Elder's teachings reveal pedagogy. They are purposefully teaching the MCC project researchers about their ways of doing and thinking. This information is used by Andrew-Ihrke and Yanez to teach classroom teachers, and out of this emerges a Yup'ik style of pedagogy.
In order to develop a culturally-based Yup'ik curriculum, it is important to understand how a Yup'ik teaches another Yup'ik. Kawagley (1995), Barnhardt & Kawagley (1999), Lipka (2005), Lipka, Wong, & Andrew-Ihrke (2012), and others have identified Yup'ik pedagogical approaches: expert-apprenticeship modeling, cognitive apprenticeship, peer tutoring, guided practice, a multidisciplinary focus, a multisensory emphasis, storytelling, visualization, experimentation, discovery, inquiry, and observation. Many of these pedagogical approaches are observable; however, they cannot be fully understood without connecting the language and cosmology that informs the pedagogical approach.

For example, at the March 2014 MCC Elders' meeting, a female Yup'ik Elder was teaching how she crafts baskets from grass. Yup'ik was the first and preferred language of the meeting. The other Yup'ik Elders in the room from various villages wanted to learn her methods. Everyone was offered grass and needles. The Elder began by showing the first step of holding two pieces of grass perpendicular in the form of +, identifying a center point, the place to begin construction. She proceeded by demonstrating how she folds the grass from the center point vertically and then horizontally in a pattern of three. She then began the stitching.

I could not understand how she got to this point after the demonstration (she demonstrated three times how to make the center point). I moved behind the Elder to get a closer look, so that I could understand what went wrong with my attempt. She motioned for me to take her beginning basket center and to sew on it as she continued instruction. She chose to teach me specifically with her basket center; I promptly sat on the floor next to her. She demonstrated how to use the needle and pull the grass thread through with several stitch repetitions. I attempted to sew on her grass center point as she watched. Eventually she made brief comments instructing tighter thread pressure or for me to hold the item differently. The Elder would reach her hand out to signal me to return the item. She indicated that she wanted me to watch her do it again. She repeated showing me how to use the needle and placed nonverbal emphasis on showing me how to correctly hold the center, needle, and thread while stitching. I now understood to hold the item perpendicular on my thigh. The angle and positioning of the core item was important to her construction method. This pattern continued: I stitched some, and then she would take the item back and demonstrate more. I would then resume my attempts at sewing.

She would tell the other Elders and learners how I was doing. The Elder began to say I was a fast sewer—like a sewing machine—with a smile and chuckle. I knew she was pleased with my progress. Some came over to observe my sewing. Other learners would ask her questions about their sewing pieces. They would show her their work and she would briefly explain using hand gestures and minimal language. The instructing Elder kept a watchful eye on how all learners were doing

while giving them specific guidance based on their work. Throughout the lesson she provided positive encouragement to everyone. This came in the form of brief statements or with a silent nod of her head with a smile.

At the end of the three-hour grass basket-sewing lesson, we shared our work and progress. This was another teaching moment. Some sewed tiny baskets with small split grass and others sewed large baskets. Some knew how to sew colored grass into patterns. When I looked at others' work, I could see various tensions on the grass thread and various sizes of stitching. Some grass items were perfectly symmetrical and mine was not. I looked at the progression of my co-produced Elder piece and began to assess my own basket construction qualities and thinking about specific techniques that I need to develop further. Although my sewing was fast, I deemed that it was not the best quality after comparing it to the work of others. I was motivated to continue grass sewing and to improve my own techniques based on observation of others' work.

While we were not in a village that was in a traditional Yup'ik setting, Yup'ik-style pedagogy was evident from the teachings of this Yup'ik Elder in terms of expert-apprenticeship modeling, peer tutoring, guided practice, discovery, inquiry, use of metaphors, self-assessment, and observation. When Yup'ik Elders are the teachers of Yup'ik activities, components of Yup'ik pedagogy and learning emerge. A description and interpretation is needed of culturally applied teaching and learning methods utilized throughout cultural activities. Teaching and learning components will be identified and described as the focus of this research.

Cognition

Observation of the Elders sheds light on innate abilities, learning preferences, and cognitive processing. The current trend in Alaska teacher preparation programs is to incorporate Universal Design for Learning (UDL). It prescribes instruction and assessment through multiple students' strengths of preferred learning modalities within a given lesson. In other words, teachers must find multiple instruction methods that will work for all students. Teachers are expected to take into consideration Howard Gardner's theory of multiple intelligences (1999), Kenneth and Rita Dunn's learning styles theory (1999), and local community culture.

UDL lessons are based on the student's cognitive strengths and provide opportunities for them to demonstrate their knowledge in a variety of formats. This is a major deviation from the current dominant education practice that most current pre-service and experienced teachers underwent as students, in which everyone must learn the same information the same way and be able to show it on a paper-pencil test.

As a current special education teacher, I develop individual learning plans and train general education staff how to teach to a given student's strengths. This requires obtaining an intimate understanding of cognitive functioning for each student through standardized cognitive and education assessments, observations of the student in and out of the classroom, interviews, and the review of work samples. After reading and interpreting countless cognitive reports, it is my opinion that Alaska Native students and non-native Alaska rural students possess different cognitive strengths than the dominant white student population in urban schools (Personal observations, 2002-2014).

While studying standardized assessments,

their cultural validity and psychological effects on Alaskan Natives and American Indians (AN/AI) in special education, I found that the U.S. Department of Education has been directed, since the 1920's, to develop and to utilize better assessment tools. This is because the current standardized assessment tools that they have utilized in the past and continue to use are, basically, culturally invalid. Unfortunately, even now, special education teachers and school psychologists are still mandated by Federal, State and local School District policy to continue using standardized assessments that are culturally invalid with regard to AN/AI students (Parsons, 2011).

My experience, as an educator in Alaska, suggests that when we teach to students' natural cognitive strengths they are more likely to master and to apply the curriculum presented in the classroom. Therefore, that element of cognition is incorporated into this research framework, as are my personal observations of Yup'ik cognitive strengths. Also included are Gardner's intelligences of naturalist, logical-mathematical, spatial, and kinesthetic, as they are the four intelligences most frequently observed. Included, as well, are Kawagley's descriptions of visual thinking, intuition, thinking in Yup'ik, and logical-sequential thinking, as well as Dunn & Dunn's frequently observed learning styles of visual, tactual, kinesthetic, global-analytical processor, and persistent. Many of these are found in the grass-basket sewing example above.

Math in a Cultural Context Project

The final element of this framework rests with the Math in Cultural Context (MCC) project. MCC has developed a balanced and respectful approach for working with ancestral knowledge given by Elders. Welcomed in this group of participant researchers, I quickly realized that the project's success is largely based upon the long-term relationships that Lipka developed with Elders over a 30-year period.

MCC practices the Four R's as described by Kirkness & Barnhardt (1991): they *respects* the Elders for whom they are; they honor and validate practices that are *relevant* to the Elder's view of the world; they practice *reciprocity* through understanding and building upon the cultural background of the Elders with emphasis on making teaching and learning a two-way processes; and they are *responsible* to the Elders, ensuring institutional respect for their Indigenous knowledge and practices. In practicing the 4 R's---respect, reciprocity, relevance, and responsibility---MCC demonstrates an ability to help Elders to appreciate and build upon their customary forms of consciousness and representations.

MCC's approach incorporates components of joint activity theory as described by Luis Radford and Wolff-Michael Roth (2011) as applied to classroom mathematical skill acquisition. Radford and Roth draw on the work of Vygotsky and Leont'ev, developing an approach to understanding specific human forms of knowing that emerge when people engage in joint activity (Radford and Roth, 2011).

An out-of-school example is the aforementioned snowshoe activity, where a powerful transition unfolded to develop a collective cultural consciousness. The common collective endeavor was to document traditional construction of the snowshoe, using traditional Yup'ik language and identifying methods. The activity began with one Elder explaining his method from a scaled model. Elders demonstrated their respective techniques, discussing purpose while collectively reflecting on and

identifying similarities and differences within the sequence of construction using specific Yup'ik terminology. Elders interactively discussed their respective societal-historical means and processes of snowshoe construction, conceptualizing the relation between the individual and village practices through language similarities and differences. As the activity unfolded with physical materials, Elders exchanged roles of teacher and student, explaining their respective embedded thought process and perspective.

Through collaborative and reciprocating interactions, Elders and researchers became acquainted with inherently collective significations ("meanings") and Elders concretized them in the form of personal sense. "These significations ('meanings') are collective because the signs used in and for communication (words, intonation, gestures, body position and orientation) are the results of, and are marked by, cultural-historical processes, which also mark personal sense." (Radford and Roth, 2011). The practical activity of snowshoe construction produced historical, collective and individual consciousness when using Radford and Roth's 2011 description of consciousness as something concrete: it is a subjective reflection of the world that expresses the concrete affective relationship between the individual and her sociocultural, historically-situated setting. Consciousness includes thinking and emotional orientation, which Radford and Roth assert can be grasped through its overt manifestations found in speech, gestures, and all sensory actions.

MCC's application of joint activity theory proves to be a research method component in which Yup'ik Elders are comfortable and willing to participate. Elders are empowered to clarify and define a cultural consciousness from their worldview that explains traditional Yup'ik construction of a cultural item containing many mathematical processes. As the Elders' information is documented in Yup'ik and English, they are asked in Yup'ik if it is recorded accurately. Corrections are made until the Elders are jointly satisfied that the documentation is reflective of what they are collectively communicating. Aspects of the MCC research approach will be incorporated into this research.

Moving forward

Current best practices for culturally-based education call for the inclusion of a group's culture, including traditional teachings from Elders, grounding in the group's heritage language, and inclusion of a group's cosmology. At the American Indian Teacher Education Conference at Northern Arizona University in Flagstaff on June 6, 2009, Dr. Demmert stated:

> Harvard professor Jerome Bruner notes, "culture shapes mind...it provides us with the tool kit by which we construct not only our worlds but our very conceptions of ourselves and our powers." He further states that, "you cannot understand mental activity unless you take into account the cultural setting and its resources, the very things that give mind its shape and scope. Learning, remembering, talking, imaging: all of them are made possible by participating in a culture" (Bruner, 1996, pp. x-xi). A child's education must include social, emotional, and ethical competencies as well as academic priorities. A growing number of schools serving Indigenous communities agree with these premises conceptually. The task as we envision it is to accomplish this in a culturally compatible and supportive environment. (Demmert, 2011, p. 1)

Dr. Kawagley, in *A Yupiaq Worldview* (1995), describes important elements that need to be considered in culturally-based Yup'ik education. He states that:

> …we should make use of the Yupiaq language because it is a tool of the spirit and therefore the voice of the culture…. Elder participation is critical to Yupiaq science teaching. Their thinking, learning, and desire to convey the age-old products of wisdom, including individual and group fortitude, values of life, liberty, and the pursuit of happiness are based firmly on Yupiaq spirituality and worldview. The premise in teaching Yupiaq science is to begin with the environment, ensuring cultural sensitivity and relevancy, because it is something Elders are most intimately in tune with. (p. 116)

The Indigenous-influenced framework in Figure 2, above, will guide the process of examining and describing Yup'ik teaching and learning within traditional activities.

The interconnected elements—Elders, language, cosmology and worldview, nature/environment, values, pedagogy, and cognition—will be taken into account as components that give mind its shape and scope. This ensures cultural sensitivity and relevancy while identifying and describing teaching and learning aspects. By using this framework, it will be possible to answer the following questions:

What are Yup'ik ways of teaching and learning, drawing on observations of Elders' engaged in traditional activities? Will culturally coded ways of teaching and learning be consistently applied between diverse and gendered traditional activities? Does the Yup'ik process of teaching and learning contain the Center Point concept identified at MCC Yup'ik Elders meetings?

Findings of this research will be available on the Alaska Native Knowledge Network (ANKN) website. ANKN was established to assist Native people, government agencies, educators and the general public in gaining access to the knowledge base that Alaska Natives have acquired through cumulative experience over millennia (http://ankn.uaf.edu). Hosted by the University of Alaska Fairbanks, ANKN is a unique online warehouse offering dynamic information related to Alaska Native knowledge systems and ways of knowing. The site offers free publications including Alaska Native cultural insight manuscripts, Indigenous educational resources, curriculum resources, lesson plans, historical information, recently published books and CD's available for purchase, and more.

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